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COSMIC RAY EQUATOR ACCORDING TO THE DATA OF THE THIRD SOVIET SPACESHIP-SATELLITE *)

(Ekvator kosmicheskikh luchey po dannym tret'yego sovetskogo korablya-sputnika)

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The utiliztion of satellites for the determination of the equator of cosmic rays, i.e. the geographic position of the line of minimum intensity of primary cosmic radiation, has many advantages by comparison with the terrestrial measurements. Thus, 22 points of the cosmic ray equator were obtained in about 20 hrs aboard the second Soviet spaceship-satellite [1].

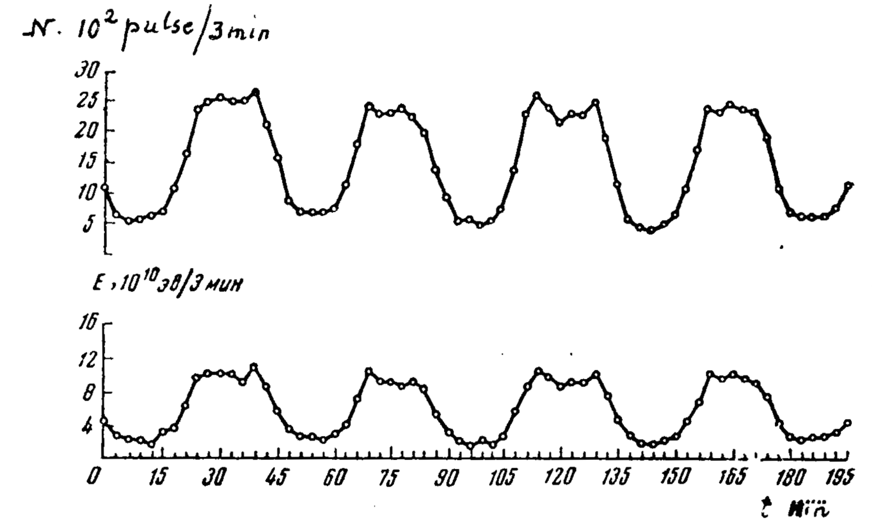

Fig.1. Counting rate N of the Geiger-Muller counter (upper curve) and energy liberation E in the crystal of the scintillation counter (lower curve), as functions of satellite's flight time.

A halogenous STS-5 gas-discharge counter, a scintillation counter provided with a NaI (Tl) crystal, and an FEU-15 photomultiplier

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*) This is an improved version of apparently the same paper published in Geomagnetism i Aeronomiya, Vol.I, No.4, 1961 (NASA TT F-8165)

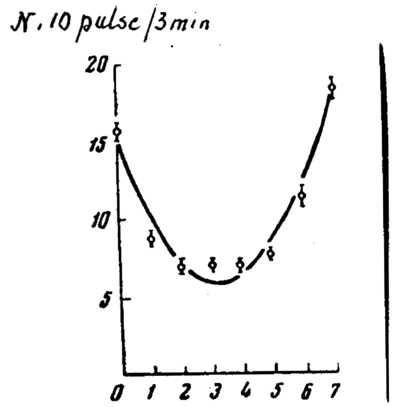
were amongst the instrumentation of the third Soviet spaceship-satellite, just as was the case in the second spaceship. The pulse-counting rate and the current were measured. From the counters pulses were fed to scaling circuits, which were interrogated by a 24-hour capacity memory device once every three minutes. Owing to such capacity the latitude dependence of cosmic radiation could be measured at every crossing of the equator. Let us add that the instruments were located inside the sapceship behind a shielding of about 5 to 150 $g \cdot cm^{-2}$ [2].

A portion of the curve indicating the dependence on time and consequently on the respective latitude of the STS-5 counting rate (upper curve), and the energy liberation in the crystal of the scintillation counter (lower curve) is plotted in Fig. 1. It must be noted that the intensity of cosmic rays measured by means of the halogen STS-5 counter in polar regions (about 3 particles $\cdot cm^{-2} \cdot sec^{-1}$) as well as and particularly at the equator (about 0.7 $p \cdot cm^{-2} \cdot sec^{-1}$), exceeds the known values of the intensity of primary cosmic rays (respectively about 1 and 0.05 particles $\cdot cm^{-2} \cdot sec^{-1}$), see ref. [3]. An analogus effect was observed in the second spaceship. The detected discrepancy may be explained by a series of causes, including the registration of the secondary cosmic ray radiation appearing in the spaceship's envelope.

It follows from Fig. 1 that both curves (upper and lower) have the same character. This means that the basic contribution to energy liberation in the crystal is made by charged particles, inasmuch as the Geiger counter registers mostly charged particles. The dependence of the counting rate of the scintillation counter on time had an entirely different character, in particular on account of brehmstrahlung registration at time of flight through the outer radiation belt [4]. The comparison of both curves allowed the exclusion of those portions, in which substantial distortions were caused by radiation belts. At low latitudes particularly great distortions

were due to the inner radiation belt [5]. Such curves were disregarded during the further processing of data determining the equator.

Thus 18 out of 22 portions of the curve obtained by each pickup, corresponding to measurements in the total latitude range, were selected as not being subject to distortional effects of radiation belts. An empiric formula, describing the latitude dependence was found for each portion by the method of least squares. At the same time a parabola of the second order constituted the approximating function*). Plotted are in Fig. 2 and 3 the experimental points, and indicated are the computed parabolae, one of which describing the latitude dependence measured by the Geiger counter, and the other — by the scintillating counter. The minima of cosmic ray intensity were determined from the obtained emprical formulas.



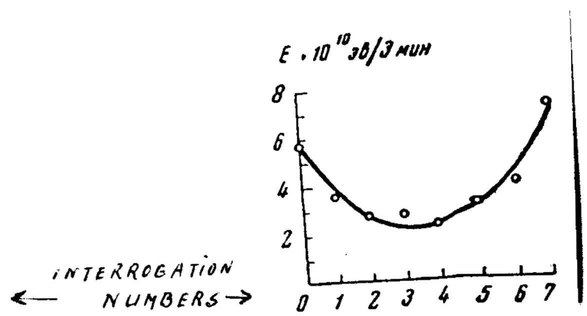


Fig. 2. Parabola of the second order $y = B_0 + B_1x + B_2x^2$, approximating the latitude dependence measured by the STS-5 counter. Time interval between two interrogations : 3 min.

Fig. 3. Parabola of the second order approximating the latitude dependence measured by the scintillation counter according to energy liberation in the monocrystal for the portion bought out in Figure 2.

Fig. 4 shows the position of the cosmic ray equator as measured by the Geiger-Muller counter installed in the third spaceship-satellite. It follows from Fig. 4 (see next page) that, within the bounds of experimental errors, its position coincides with that measured aboard the second spaceship-satellite [1], and agrees well with that computed theoretically in the assumption that the Earth's magnetic field

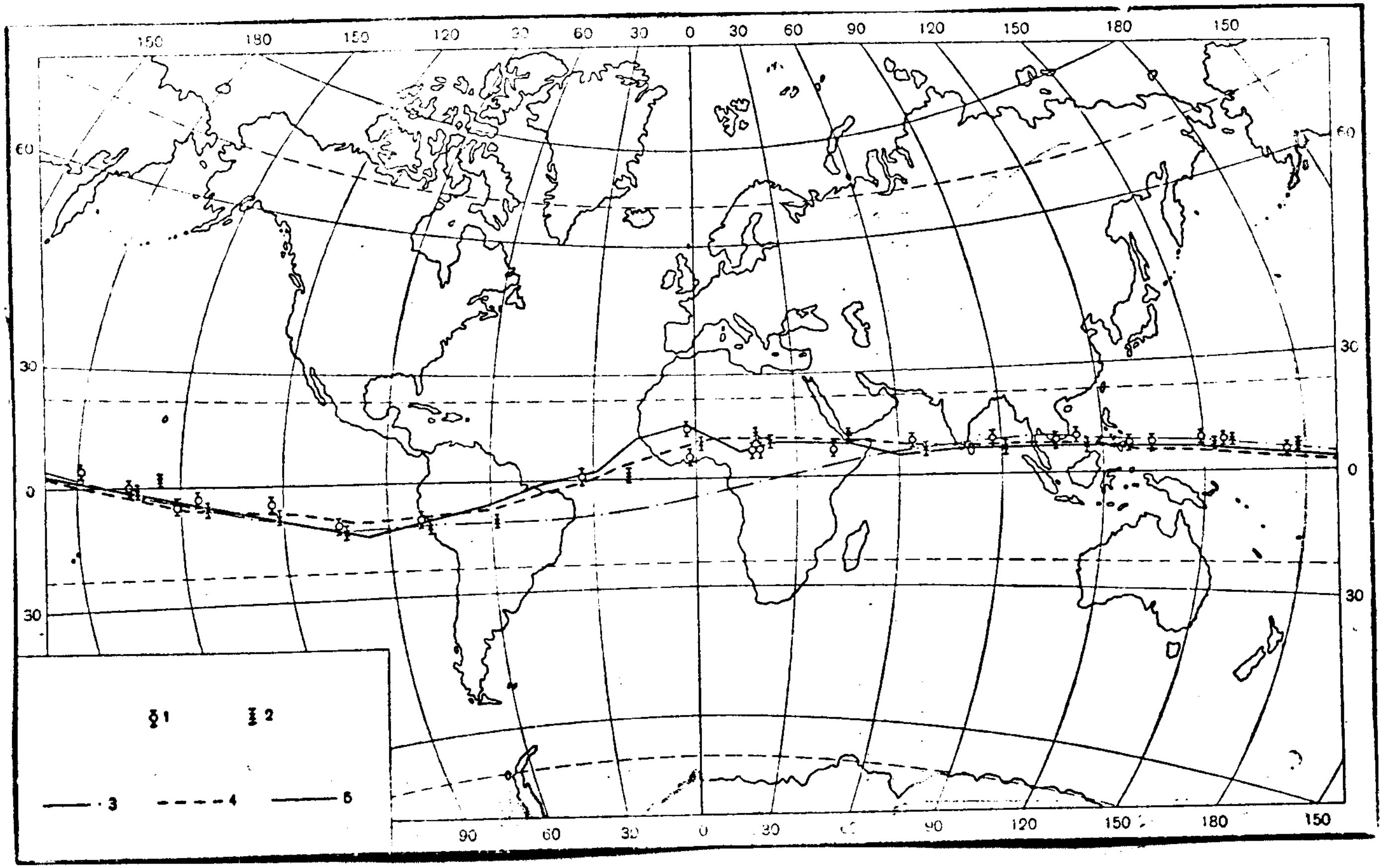


Fig. 4. Position of Cosmic Ray Equator according to measurements aboard spaceship-satellites, using Geiger-Muller Counters:

1 — 2nd specship-satellite; 2 — third spaceship-satellite; 3 — equator computed in the assumption of a dipole character of the geomagnetic field; 4 — equator computed by Quenby and Webber; 5 — equator computed by Kellog and Schwartz in the octuple approximation.

is not dipole [7, 8]. The located position of the equator of cosmic rays also coincides sufficiently well with the equator of the 1955 epoch's zero inclination.

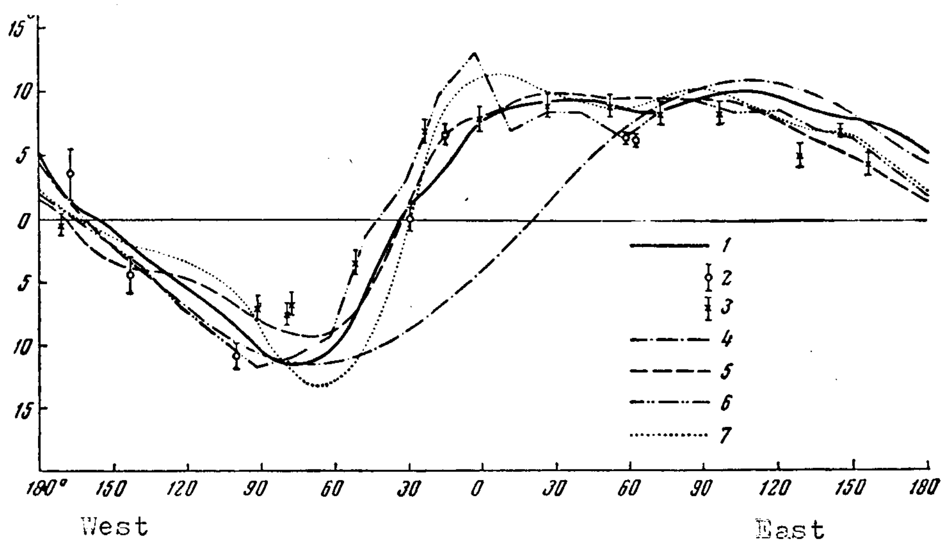


Fig. 5. COSMIC RAY EQUATOR:

1 — averaging of results obtained in the 2nd spaceship by the Geiger counter, and in the 3rd spaceship by both, the Geiger and the scintillation counter; 2 — experimental results of equator measurement at sea level [6, 9 — 12]; 3 — experimental points obtained in aircraft [13 — 15]; 4 — equator computed in the assumption of a dipole character of the Earth's magnetic field; 5 — equator computed by Quenby and Webber taking into account the non-dipole part of the geomagnetic field [7]; 6 — equator computed by Kellog and Schwartz in the octuple approximation [8]; 7 — equator of the zero inclination of the 1955 epoch.

The cosmic ray equator determined in the third spaceship-satellite according to energy liberation in the scintillation counter's crystal, coincided with a precision to 1° by latitude, and to 0.4° by longitude with the equator measured by the Geiger counter.

The solid line of Fig. 5 indicates the position of cosmic ray equator obtained as a result of averaging data of the 2nd (one pickup) and 3rd (two pickups) spaceships. The averaging was effected for points, lying in a 5° longitude interval. The mean-square error

of the result of determinationof the position of each point of the equator by three measurements was as an average equal to $\sim 1^{\circ}$. Plotted also are in Fig. 5 the results of measurements of cosmic ray equator at sea level [6, 9 — 12], and at altitudes reached by aircraft [13 — 15].

It follows from Fig. 5 that the cosmic ray equator measured at 200 to 300 km height with the aid of spaceship-satellites, is in rather good agreement with the equator computed by Quenby and Webber [7], also with that found in octuple approximation by Kellog and Schwartz [8]. For a more detailed comparison, it is necessary to increase the precision of latitude dependence measurement, in particular by way of frequency increase of pickup interrogation and by a reduction of statistical errors.

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